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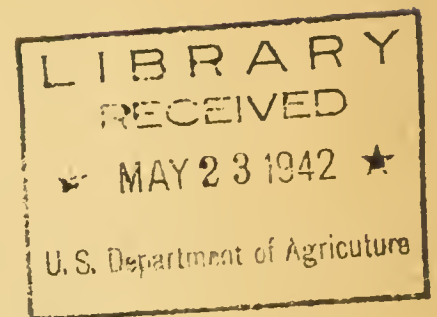
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IRRIGATED FARM PASTURES FOR THE STATE OF UTAH

By

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## Introduction

Livestock constitutes a definite asset on the farm lands of the State of Utah. They provide a practical and profitable means for marketing feed crops and, in addition, the manure which is produced is an important factor in maintaining the productive capacity of the soil. Practical diversified farming is made possible only when livestock are included as a part of the farm organization.

We are fortunate in that alfalfa, which is a good soil builder, constitutes our main feed crop. The soil building properties of the alfalfa itself, plus the fertilizer developed by farm livestock, should play, and on many farms does play, a very important part in the soil fertility program. For the improvement of soil fertility, stabilization of soil against erosion, and for the increase of organic matter in the soil, grass-legume mixtures are more valuable than alfalfa alone and when used the crop should be made to fit into the rotation for the farm wherever possible. The roots and crowns of a mixed pasture are usually from two to four times greater in weight than the roots and crowns of an alfalfa stand alone and are better distributed throughout the top  $\frac{1}{4}$  feet of the soil. In addition to its soil fertility and organic matter improvement qualities, a properly managed grass-legume pasture will provide the livestock farmer with his cheapest seasonal feed for work stock, dairy or beef cattle, and sheep. Many farms throughout the State have one or more classes of these livestock, yet a major portion of the farmers have not considered a permanent pasture as a regular farm crop. Too often we think only of planting irrigated pastures on the poorer part of the farm when as a proven fact the best land will often give higher net returns when planted to a grass-legume pasture than will be secured from so-called cash crops or feed crops that have to be harvested and fed from the stack. Irrigated pastures can often compete with the more intensive cash crops on the best soil, and are superior to cultivated crops for land having an erodible grade or for land having a high water table during part of the growing season. Irrigable, stony land or land having a top soil too shallow for the production of cultivated crops can often be profitably handled as irrigated pasture land.

Farm animals require a certain definite amount of feed nutrients each day. This requirement is in proportion to the live weight and productive activity of the individual animal and must be met by a daily feed supply to prevent a loss in weight, a loss in production, or both. In order to maintain the normal body weight and perform the normal body functions without any productive activity, it requires approximately 16 pounds of alfalfa hay daily or its equivalent in other feeds for a mature horse or cow weighing 1000 pounds. For a period of one year this amounts to 5,840 pounds of alfalfa hay or its equivalent for each 1,000 pounds of mature livestock. On top of this there is, of course, an additional feed requirement for productive activity which is in proportion to the production whether it be growth, reproduction, work, milk, fattening, wool, or a combination of two or more of these functions.

The pasture growing season in Utah depends on the plant species and varies with the locality from about 4 months in higher elevations to 7 or 8 months in the lower elevations. Temperature and other climatic

factors, as well as soil factors, vary widely throughout the State, and must be taken into account in the selection of species for the pasture mixture.

### Planning the Pasture

Enough land should be devoted to the growing of pasture to provide grazing for all livestock kept on the farm. Among factors which influence the adaptability of various species of pasture grasses and legumes and the carrying capacity are type and depth of soil, depth to water table, soil fertility, availability and reliability of the irrigation water supply, drainage, alkali concentration, maximum and minimum temperatures and length of growing season. In the higher elevations of the State, with an ample supply of irrigation water and a well-drained, highly productive soil, carrying capacities as high as 5 animals per acre for a period of 5 months have been reported.

It is necessary that the farm planner anticipate the expected results when planning a pasture. In general where there is ample irrigation water and good soil, 3 animal units per acre for the duration of the growing season can be anticipated in the higher elevations. Likewise, for the lower elevations such as exist in the vicinity of St. George, 2 to 3 animal units per acre for the growing period can be safely anticipated. If irrigation water is limited during any or all of the growing season or other factors are present which will influence production, carrying capacity estimates should be adjusted accordingly.

On farms where dairy cows are kept, it is desirable that the pasture be as close to the barns as possible, at least that portion of the pasture which is to be used by the dairy cows. For other classes of livestock the pasture should be located with the view of making it an integral part of the cropping system. However, the availability of livestock water should be taken into consideration.

### Seedbed Preparation, Time and Method of Seeding

Because of the relatively high value of irrigated land, the high cost of seed, and the fact that the pasture will occupy the field for several years, great care should be taken in leveling the land for irrigation and in preparing the seedbed. A well-pulverized, clean and firm seedbed will insure a good, even stand and a quick vigorous growth of the pasture grasses and legumes. Good stands can better compete with weeds. Less seed is necessary on a well-prepared seedbed. If the land is infested with perennial noxious weeds, it should be clean cultivated until the weeds are eradicated before the pasture is planted. In the southwestern part of the State the pasture should be seeded in the cooler part of the year far enough in advance of the hot summer, if spring planted, so that plants will become sufficiently well established to withstand summer temperatures. If fall planted, the summer growers should attain a size large enough to withstand the winter temperatures. In other parts of the State, there are 3 seasons when seeding may be done and satisfactory results obtained. The first season is early in the spring

of the year about the time or just before alfalfa is customarily planted. At this time, both the grasses and legumes can be planted. The second season is in the late summer or early fall of the year, early enough that the plants will become well established before freezing temperatures are encountered. In most localities this is the best time to plant because there is less evaporation, little weed competition, and consequently, less water is required. The third season (to be recommended only where irrigation water supply is short and spring run-off must be utilized to secure a stand) is late in the fall or early winter. Such seedings should be performed late enough that no germination will occur until the following spring. The more hardy grasses are all that should be seeded at this time with the clovers and other legumes being added the following spring after the danger of freezing temperatures has passed.

Seeding is best done with a grain drill set to run as shallowly as possible. The seed should be planted to a depth of from  $1/2$  to  $3/4$  inches. The grass seed should be thoroughly mixed and seeded through the grain hopper, while the legumes may be seeded through an alfalfa seeding attachment. If the alfalfa seeding attachment is not available, the legumes may be broadcast over the field and harrowed in before the grass is seeded. If no drill is available, the entire mixture may be broadcast and covered with a spike-tooth harrow on which the teeth are set at a slight angle.

#### Establishment of Pastures

The success of an irrigated pasture often is determined by the care it receives during the first year. Frequent, light irrigations are very important during the time the seed is germinating and the plants becoming established in order to keep the surface soil well supplied with moisture and prevent the formation of a crust through which the seedlings cannot emerge. Uniformly moist conditions insure thick stands and vigorous growth, two essentials for a high carrying capacity.

Where a nurse crop is grown, it should be removed as a hay crop in order to avoid competition with the pasture grasses and legumes which after all is the crop the farmer is interested in establishing. If no nurse crop is used, it will be necessary, in most localities, to mow spring or early summer planted pastures one or more times to reduce weed competition. It is much more desirable that a nurse crop not be used inasmuch as the stand of pasture plants will in most instances become better and more quickly established if they are not subjected to such competition. If the farmer insists on planting a nurse crop with his pasture, the rate of planting for the nurse crop should be not more than  $1/2$  of the normal rate.

The newly seeded pasture should not be grazed until the faster growing grasses have attained a height of 6-8 inches and not then unless the soil is dry enough to be firm. In general, however, it is much safer, and in the long run more satisfactory, to defer all grazing until at least one cutting for hay has been made.

### Pasture Management

A common mistake in irrigated pasture management is to turn the stock on the pasture too early in the spring or, worse still, never to take the stock off. Young tender pasture plants have a high water content and a rather low feed value, and, therefore, furnish relatively small amounts of feed nutrients even though the animals are able to get a fill easily. These young, tender plants need to develop more leaf and root surface at this early stage of growth in order to furnish more grazing later in the season. Therefore, from the standpoint of both the animal and the pasture it is better to wait until the grasses and clovers get a good start in the spring before turning the animals on the pasture.

Approximately 95 percent of the root system of most pasture plants is found in the first 3 or 4 feet of soil. Frequent, light applications of irrigation water are, therefore, more desirable than heavy applications at wider intervals. Heavy irrigations which wet the soil below 3 or 4 feet or which constitute an amount of water in excess of the amount required to wet the entire soil profile of a shallow soil which is less than 3 or 4 feet in depth is a waste of water and causes unnecessary leaching of plant nutrients.

A problem on well improved heavily stocked pastures is to distribute the droppings which accumulate. A spike-toothed harrow properly weighted so as to hold it to the ground is the best implement to use for this purpose.

Maximum carrying capacity of irrigated pastures is possible only by a systematic plan of alternate grazing and irrigation. The pasture should be divided into at least two fields so that one can be grazed while the other is being irrigated. When the grass on the field being utilized is mostly eaten off, the livestock should be shifted to the field which has been irrigated and rested. The droppings on the utilized field should be scattered if necessary and the field then irrigated and allowed to remain idle until the grasses are at least 4 inches in height or until it is necessary to again rotate the grazing livestock. The soil should always be dry enough to be firm before grazing is commenced.

More damage accrues to irrigated pastures through trampling when the soil is wet than in any other one way. Trampling a wet soil destroys many plants and leaves the soil in a poor physical condition which recovers but slowly. Livestock should therefore be kept off of a pasture, if possible, immediately after irrigation or after a heavy rain until the top soil has become firm and dry enough to support the weight of the animals without injury to the sod cover.

### Pasture Fertilization

Most irrigated pastures respond favorably to the application of fertilizer because of the heavy demand of the grasses on the available plant nutrients.

Top dressing with barnyard manure each year will increase yields. The manure should be applied during the winter. Early the following spring the pasture should be harrowed, if necessary, to distribute lumps which have persisted through the winter. It is the usual practice in most localities to apply 10 tons or more of barnyard manure per acre when sufficient quantities are available.

Good response in most localities is obtained from the application of commercial fertilizers. It is a good practice to apply phosphates at seeding time and each year thereafter, phosphate being the nutrient more apt to be deficient in our western soils. Treble superphosphate should be applied at the rate of about 100 pounds per acre. Greater amounts may pay dividends unless sufficient manure is available.

### Grass Mixtures for Permanent Pastures in Utah

For permanent pastures, it is better to seed a mixture of grasses and legumes instead of a single species. It has been proven that a mixture which consists of various species which will produce growth during different periods of the growing season will produce much more volume than a single species, and from other standpoints is more desirable. The danger from bloat in such pastures is much less than in a straight legume pasture, there being small likelihood of an occurrence of this trouble when the pasture contains considerable grass.

It is impossible to use an identical mixture for all the various conditions found within the State of Utah. Climatic differences, soil and alkali variations, and available irrigation water supply make it necessary to use different mixtures in different localities. Conditions vary so widely and change in such short distances that it is impossible to exactly zone the State and prescribe mixtures for each zone.

In the following mixtures, an attempt has been made to recommend pasture mixtures for three different groups of conditions, these groups being based primarily on differences of climate, alkalinity and moisture. For simplicity's sake, specific locations have been mentioned for each group. Technicians will undoubtedly be acquainted with conditions existing in some of the specified places and will be able to determine if their conditions are similar in nature. It may be necessary for the technicians to vary the suggested mixtures somewhat as availability or price of seed and other factors might dictate. The mixtures listed below are merely recommendations based on the best information available.

#### Group I

For the following locations or localities exhibiting similar climatic and soil conditions, use of the following mixtures is recommended:

Salt Lake City	Fillmore
Morgan	Minersville
Mt. Pleasant	Enterprise
Monticello	Cedar City

Mixture 1 - Slight to moderate alkali, no shortage of irrigation water.

Perennial ryegrass ( <i>Lolium perenne</i> )	4 lbs.
Meadow fescue ( <i>Festuca elatior</i> )	4 "
Orchard grass ( <i>Dactylis glomerata</i> )	4 "
Timothy ( <i>Phleum pratense</i> )	3 "
*Kentucky bluegrass ( <i>Poa pratensis</i> )	Varies
Smooth brome grass ( <i>Bromus inermis</i> )	4 "
Reed canary grass ( <i>Phalaris arundinaceae</i> )	4 "
Alfalfa ( <i>Medicago sativa</i> )	2 "
Alsike clover ( <i>Trifolium hybridum</i> )	) 1 species 2 "
White Dutch clover ( <i>Trifolium repens</i> )	
Ladino clover ( <i>Trifolium repens</i> , var. <i>latum</i> )	
Per acre	27 "

\*If Kentucky bluegrass occurs naturally in locality where pasture is being planted, it should be omitted. If it is included, use 2 lbs. per acre in mixture and reduce perennial ryegrass and meadow fescue by 1 lb. each.

Mixture 2 - Slight to moderate alkali, non-continuous water supply. Same as Mixture 1 above except do not use ladino, alsike or white Dutch clover.

Mixture 3 - Alkali land with high water table.

Reed canary grass ( <i>Phalaris arundinaceae</i> )	8 lbs.
Redtop ( <i>Agrostis alba</i> )	4 "
Meadow fescue ( <i>Festuca elatior</i> )	4 "
Strawberry clover ( <i>Trifolium fragiferum</i> )	4 "
Per acre	20 "

Mixture 4 - Dry land, no irrigation (singly or in combination).

Slender wheatgrass ( <i>Agropyron pauciflorum</i> )	4 lbs.
Crested wheatgrass ( <i>Agropyron cristatum</i> )	4 "
Western wheatgrass ( <i>Agropyron smithii</i> )	5 "
Per acre	13 "

Group II

For the following location and for localities exhibiting similar climatic and soil conditions, use of the following mixtures is recommended:

St. George

Mixture 1 - Slight to moderate alkali, no shortage of irrigation water.

Dallis grass ( <i>Paspalum dilatatum</i> )	9 lbs.
Rhodes grass ( <i>Chloris gayana</i> )	6 "
Harding grass ( <i>Phalaris tuberosa</i> )	6 "
Burr clover ( <i>Medicago hispida</i> )	1 "
Button clover ( <i>Medicago orbicularis</i> )	1 "
Alfalfa ( <i>Medicago sativa</i> )	<u>2 "</u>
Per acre	25 "

Mixture 2 - Slight to moderate alkali, non-continuous water supply.

Rhodes grass ( <i>Chloris gayana</i> )	8 lbs.
Weeping lovegrass ( <i>Eragrostis curvula</i> )	2 "
Giant panic grass ( <i>Panicum antidotale</i> )	5 "
Alfalfa ( <i>Medicago sativa</i> )	<u>3 "</u>
Burr clover ( <i>Medicago hispida</i> ) or Button clover ( <i>Medicago orbicularis</i> )	1 "
White sweet clover ( <i>Melilotus alba</i> ) or Hubam clover ( <i>Melilotus annua</i> )	<u>1 "</u>
Per acre	20 "

Mixture 3 - Alkali land with high water table.

*Bermuda grass ( <i>Cynodon dactylon</i> )	6 lbs.
Harding grass ( <i>Phalaris tuberosa</i> )	6 "
Yellow sweet clover ( <i>Melilotus officinalis</i> ) or White sweet clover ( <i>Melilotus alba</i> )	3 "
Alfalfa ( <i>Medicago sativa</i> )	<u>3 "</u>
Per acre	18 "

\*Not to be recommended where State quarantine laws prohibit its use. In these cases use more Harding grass.

Group III

For the following locations and for localities having similar climatic and soil conditions, the following mixtures are recommended:

Roosevelt  
Huntington  
Price  
Panguitch

Mixture 1 - Slight to moderate alkali, no shortage of irrigation water.

Orchard grass ( <i>Dactylis glomerata</i> )	4 lbs.
Meadow fescue ( <i>Festuca elatior</i> )	3 "
Smooth brome grass ( <i>Bromus inermis</i> )	5 "
Perennial ryegrass ( <i>Lolium perenne</i> )	4 "
Timothy ( <i>Phleum pratense</i> )	2 "
Tall meadow oatgrass ( <i>Arrhenatherum elatius</i> )	4 "
Alfalfa ( <i>Medicago sativa</i> )	2 "
Red clover ( <i>Trifolium pratense</i> )	) 2 species
Alsike clover ( <i>Trifolium hybridum</i> )	
Ladino clover ( <i>Trifolium repens</i> , var. <i>latum</i> )	) 1 lb. of 2 "
White Dutch clover ( <i>Trifolium repens</i> )	
Yellow sweet clover ( <i>Melilotus officinalis</i> )	) each
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Per acre	26 "

Mixture 2 - Slight to moderate alkali, non-continuous water supply. (Same as above, except do not use ladino, alsike, red, or white Dutch clover).

Mixture 3 - Alkali land with high water table.

Meadow fescue ( <i>Festuca elatior</i> )	3 lbs.
Reed canary grass ( <i>Phalaris arundinaceae</i> )	5 "
Perennial ryegrass ( <i>Lolium perenne</i> )	3 "
Redtop ( <i>Agrostis alba</i> )	2 "
Smooth brome grass ( <i>Bromus inermis</i> )	2 "
Western wheatgrass ( <i>Agropyron smithii</i> )	3 "
Strawberry clover ( <i>Trifolium fragiferum</i> )	2 "
Yellow sweet clover ( <i>Melilotus officinalis</i> )	3 "
Ladino clover ( <i>Trifolium repens</i> , var. <i>latum</i> )	2 "
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Per acre	25 "

### Grasses Suitable for Pasture

Redtop (Agrostis alba) is very well adapted to wet lands and to well drained soils where there is no deficiency of irrigation water. It is highly tolerant to alkali, being adapted to a slightly lesser degree of accumulation than reed canary grass. Its climatic adaptation is similar to reed canary grass.

Crested wheatgrass (Agropyron cristatum). A long-lived perennial bunchgrass. Is leafier than slender wheatgrass. Grows 24 to 30 inches in height. Is markedly drought resistant and will endure almost any degree of cold. Starts growth very early in the spring and one of the latest to become dormant in the fall. During dry, hot summers its growth ceases but is resumed as soon as soil moisture is restored and cooler weather sets in. Nutritious and palatable as hay or pasture. Abundant seed production. It is better for dry land plantings or for situations where the irrigation water supply is not ample than where there is sufficient water, because there are other species which will give a higher yield of forage if there is no shortage of water.

Slender wheatgrass (Agropyron pauciflorum orenerum) is fairly drought resistant once established. It is a short-lived bunchgrass and is not the equal of crested wheatgrass and brome grass in its ability to survive drought. It is a rapid grower for the first year or two after planting and during this time produces considerable forage. It is tolerant to moderate amounts of alkali. It will grow and produce fairly well anywhere in the State that crested wheatgrass is adapted, but does the best in the northern cooler parts. It is not recommended for irrigated pastures because other species will out-produce it in the matter of forage over a long period of time. It should find a place in dry land seedings.

Western wheatgrass (Agropyron smithii) is a sod-forming grass and spreads rapidly by underground rootstocks. It thrives best on heavy soils and will tolerate extreme drought and fairly heavy amounts of alkali. Seed of western wheatgrass is usually of low germination and only seed of certified germination should be purchased. It is very palatable and under proper conditions will make very good pasture. It is a good grass to use either alone or in mixture with other grasses where the supply of irrigation water is short. The grass is particularly good for winter grazing because it remains palatable upon drying and retains much of its nutritious quality. When cut in the early heading stage or soon thereafter, it makes excellent hay.

Tall meadow oatgrass (Arrhenatherum elatius) is adapted to the cooler portions of the State. It does best on loam and clay loam soils. It is very cold resistant and will tolerate moderate amounts of alkali. It will thrive in fairly wet soils but is less tolerant to water than reed canary grass. It is easy to establish and is a heavy producer of forage for the first two or three years in a pasture, but is relatively short lived, usually being crowded out by other grasses such as brome grass, Kentucky bluegrass and orchard grass. It is an excellent pasture grass when mixed with other species. It will do well in most portions of the State where irrigation water is sufficient for production of brome or orchard grass.

Smooth brome grass (Bromus inermis) is a long lived perennial highly resistant to cold and drought. It is especially adapted to areas of low rainfall in cooler parts of the State, prefers rich clay loam but succeeds well on sandy soils. Brome grass stands trampling well, is very palatable, and is one of the first grasses to begin growth in the early spring and one of the last to cease growing in the fall, going through a dormant period during the hotter months except at high altitudes where the temperature is fairly cool throughout the entire growing season. It is valuable in mixtures with other grasses and legumes and constitutes a valuable addition to alfalfa seedings. Brome grass develops an extensive root system and may become sod bound in which case preparation of a new seedbed and reseeding or renovation by discing or other methods may be necessary. Brome grass will stand moderate amounts of alkali.

Rhodes grass (Chloris gayana) is a perennial bunchgrass which spreads by seed. It is a summer grower, and is promising for use in warmer parts of the State where temperatures do not go below 15°F. Palatability fair to low as it is not eaten too well when plants become large or other feed is available. It is quite drought resistant and makes rapid growth when moisture is available. It is easily established in early summer.

Bermuda grass (Cynodon dactylon) constitutes one of the most important pasture grasses in the southern United States. It is adapted to practically all soil types of the warmer parts of the State. It is palatable and all classes of livestock will utilize it. Close grazing improves its quality as its stems become unpalatable with age. It is strictly a warm weather grass. Its usefulness as a grazing crop extends over the period of spring, summer and fall weather. It goes dormant with the first frost, and also during the growing season if it becomes extremely dry but will recover from drought soon after moisture again becomes available. It spreads both by stolons and underground stems and very little by seed. One method of propagation is by planting small pieces of sod or parts of the runners. These may be scattered and plowed or disced into the soil or pieces dropped into furrows 3 or 4 feet apart and lightly covered. Bermuda grass seed usually is of low germination; however, the seed can be planted and satisfactory results obtained if a rather heavy rate of planting is used. It is considered as a noxious weed in some States.

Orchard grass (Dactylis glomerata) is a long-lived perennial which spreads by underground stems and by seed. It is very cold resistant and does well in the northern and central portions of the State. It will not thrive under conditions of extremely high temperatures such as exist in the Salt River Valley or at Las Cruces. Like brome grass, it lies dormant in the hotter months except at the higher altitudes where the climate is fairly cool for the entire growing season. Orchard grass is aggressive like Kentucky bluegrass and will eventually crowd out species such as brome grass, meadow fescue, perennial rye, etc. It is fairly alkali tolerant and does well where there are moderate amounts. It will not do well in soils which are continually wet.

Weeping lovegrass (Eragrostis curvula) is a perennial bunchgrass 3-4 feet high, leafy, and not eaten too readily by stock. Heavy seed producer and spreads readily from seed. It is quite drought resistant and can be used in pastures where there is a shortage of water during the growing season. It is not recommended for use in irrigated pastures in the central and northern part of the State. It is easily established in early summer.

Meadow fescue (Festuca elatior) has about the same soil and climatic requirements as Kentucky bluegrass and timothy. It is, however, more tolerant to alkali and will thrive on soils possessing a much higher alkali concentration. Meadow fescue possesses a much leafier growth than timothy and therefore produces more volume. It is a desirable grass in pasture mixtures for all except the extreme southern parts of the State.

Perennial ryegrass (Lolium perenne) is a cool weather grower. In the cooler, northern parts of the State, it produces throughout the growing season, but in the southern parts of the State it will go dormant during the hottest months growing only in the fall, spring and winter months. Perennial ryegrass spreads by seed and underground stems. It withstands severe cold. In production, it is similar to orchard grass, producing a large volume of very palatable forage. The grass is easy to establish, the seed germinating very readily. It is tolerant to rather high concentrations of alkali and will stand considerable water; however, not as much as reed canary grass. The grass is good in pasture mixtures with bromegrass, orchard grass, meadow fescue and pasture legumes.

Giant panic grass (Panicum antidotale) is a perennial bunchgrass spreading by means of seed and short rhizomes. It is 4-6 feet high, leafy but becomes woody if allowed to become large. It is a summer grower and makes the best growth in warmer parts of the State. At Albuquerque it was a failure in irrigated pastures. It is easily established in early summer.

Dallis grass (Paspalum dilatatum) is a bunchgrass adapted to the warmer sections of the State. It is not exacting in its soil requirements but prefers heavy or loamy soils. It does not do as well on poor lands as bermuda grass unless it has an ample supply of moisture. It is 2 to 3 weeks earlier than bermuda and will also grow for 2 or 3 weeks in the fall after bermuda has been frosted. It is not injured by light freezes and is very adaptable to lowlands. It will withstand frequent flooding without injury. It will tolerate a rather heavy alkali accumulation and thrives well in wet soils as long as water does not stand for periods greater than 3 or 4 days at a time. The seed of this grass is usually very low in purity and germination and is difficult to establish.

Reed canary grass (Phalaris arundinaceae) is native to the United States. Although naturally a grass of moist or wet land, it succeeds splendidly on high, well-drained soils where moisture is not so high. It grows 4 to 7 feet tall, is considered as a bunchgrass and is very palatable both as hay and pasture. It begins growth very early in the spring. It is very hardy. It is highly alkali resistant, ranking slightly below bermuda grass in this respect. It is good in pasture mixtures and furnishes a large volume of forage. A strain of reed canary grass called the Highland Strain has been developed which supposedly is better adapted to drier situations than the ordinary strain.

Harding grass (Phalaris tuberosa) is a perennial bunchgrass spreading by seed and short rhizomes. It is an excellent grass for use in pastures in warmer parts of the State for winter feed. It mixes well with alfalfa. In the central parts of the State this grass does as well as reed canary or meadow fescue on alkali land. More information is needed before it can be recommended for use in the northern part of the State. Plant in early spring or late summer.

Timothy (Phleum pratense) is a distinctly northern grass and does not spread by underground stems as does Kentucky bluegrass and brome grass. In its range of adaptation it is similar to Kentucky bluegrass, and may be seeded for hay or pasture purposes. It is very resistant to cold, produces well, germinates easily, and is easily established. Seed is usually relatively low in price. It can be used satisfactorily with other pasture and hay crops in mixtures and it stands trampling and grazing well. It thrives on moderately acid soils and does well on soils which are slightly to moderately alkaline providing there is sufficient moisture. The grass is not usually long lived and will give way to Kentucky bluegrass or other sod-forming grasses.

Kentucky bluegrass (Poa pratensis) is a long-lived perennial having a wide range of adaptation but being better adapted to the cooler climates of the State. The grass spreads both by seed and creeping underground stems. It blooms but once each year. Kentucky bluegrass is remarkably resistant to cold but usually does not produce much growth during the hot months except at the higher elevations. It is an aggressive grass and under favorable conditions will crowd out other grasses. In areas where this grass grows naturally along ditches and comes into non-cultivated fields of its own accord, it is recommended that none be added to the pasture mixture.

### Legumes Suitable for Pastures

Burr clover (*Medicago hispida*) is adapted only to the warmer portions of the State and is an annual and a winter grower. It is tolerant to a rather high concentration of alkali and thrives best on heavy soils. However, it will do well on lighter soils if plenty of moisture is available. Burr clover produces seed in a burr-like pod and most of the seed on the market is in that form. It is unnecessary to inoculate if the burrs are planted because the organism is carried in the particles of dirt which adhere to the burrs. If hulled seed is planted on land where burr clover has never grown, it should be inoculated. In volume production, this clover is similar to strawberry clover. The clover will often reseed itself from year to year.

Button clover (*Medicago orbicularis*) is similar in adaptation and production to burr clover. However, it is less winter hardy. It is also an annual and likewise reseeds itself. Commercial seed is normally hulled and inoculation is necessary if the organism is not already present in the soil.

Alfalfa (*Medicago sativa*) is an excellent pasture legume as well as hay. It has a very wide range of adaptation, being adapted to almost all soil and climatic conditions found in the State except extremely wet or alkaline situations. It withstands rather large amounts of alkali, however. Alfalfa is very palatable and nutritious and is high in protein. It therefore makes a very good addition to a pasture mixture. In the past there has been a considerable loss of livestock by bloating caused by alfalfa. This trouble, however, appears to be largely overcome when grasses are mixed with it in sufficient quantity. This legume should be included in pasture mixtures except for situations where there is excess water or large amounts of alkali.

White sweet clover (*Melilotus alba*) is a biennial very similar in adaptation and production to yellow sweet clover. On a good soil, white sweet clover will produce more volume than yellow sweet clover and the seed is usually cheaper.

Yellow sweet clover (*Melilotus officinalis*) is a biennial producing the most of its volume growth the second year. It will not persist after the second year unless some of it is allowed to go to seed. It is fairly drought resistant and tolerates rather heavy accumulations of alkali. It does best on heavy soils; however, will produce satisfactorily on lighter soils, provided it has an ample supply of moisture. The clover is unpalatable to most classes of livestock except in its younger stages of growth, this being an undesirable quality. There is some danger from bloat unless animals are slowly accustomed to utilizing it. Yellow sweet clover is preferred in most localities over white sweet clover.

Strawberry clover (*Trifolium fragiferum*) is an excellent legume for soils possessing a high concentration of alkali or for wet situations. Although strawberry clover thrives on an ample supply of moisture, it is also fairly drought resistant once it is fully established. Except where it has a good supply of moisture, it produces very little volume. Strawberry clover spreads rapidly under favorable conditions by runners which root at the nodes, therefore, only a low rate of seeding is necessary. The seed is rather expensive due to the difficulty of harvesting and threshing. It is the best legume for wet or extreme alkali conditions. However, other species will produce much more volume where soil type and moisture conditions are more favorable and alkali is less severe.

Alsike clover (*Trifolium hybridum*) is a short-lived perennial with a wider range of adaptation than red clover. It is adapted to rather wet soils and will tolerate small amounts of alkali. The seeds are small, one pound containing approximately as many seeds as 3 pounds of red clover. It is adapted to the cooler sections of the State and will produce very little in the southern parts. Its soil and climatic adaptations are very similar to those of ladino or white Dutch clover.

Red clover (*Trifolium pratense*) is a biennial which constitutes an excellent temporary legume in a permanent pasture. It is particularly well adapted to wet soils which possess a low alkali content, but will tolerate dry situations and moderate amounts of alkali after it has become well established. It produces more volume growth than most clovers but is only temporary in nature. It does best where there is an ample supply of moisture and is not adapted to the hotter sections of the State.

White Dutch clover (*Trifolium repens*) starts growth early in the spring and grows late in the fall. It spreads by seed and creeping stems. It will grow well on any soil that will produce the common pasture grasses. It prefers a fertile soil and an ample supply of moisture. If water becomes short, it will go dormant and then start growing again as soon as more moisture is available. It will not do well in the southern parts of the State. It is more adaptable to the cooler sections. It grows well with sod-forming grasses as well as bunchgrasses. It will tolerate only moderate amounts of alkali. White Dutch clover unfortunately has some objectionable qualities. If there is a high predominance of it in the pasture, it will cause horses to slobber and is one of the worst clovers for causing bloat. However, neither one of these troubles is encountered where the pasture mixture has the proper ratio of clover to grass which is 30% clover or legume and 70% grass. Grazing livestock should have access to plenty of salt and water which helps in preventing bloat.

Ladino clover (*Trifolium repens*, var. *latum*) is a variety of white Dutch clover. It is similar to ordinary white Dutch clover in adaptation, although probably not quite as cold resistant, spreads more slowly and is somewhat shorter lived. It produces much more volume than the ordinary white Dutch clover but will not stand severe grazing. It has been reported that ladino clover will produce twice the volume of white Dutch clover under a system of rotation grazing.